

**CLAIMS**

We claim:

[0107] 1. A composition comprising brine solution including an effective amount of a divalent cation, at least one pollutant and having a salinity between about 3% and about 15%, where the effective amount of the divalent cation is sufficient to produce a divalent to monovalent cation mole ratio of at least 0.05 in the brine solution and where the brine solution is capable of supporting and sustaining growth of a microbial culture capable of degrading the at least one pollutant.

[0108] 2. The composition of claim 1, wherein the divalent cation is selected from the group consisting of  $Mg^{2+}$ ,  $Ca^{2+}$ ,  $Sr^{2+}$ ,  $Ba^{2+}$ , and mixtures or combinations thereof.

[0109] 3. The composition of claim 1, wherein the divalent cation is selected from the group consisting of  $Mg^{2+}$ ,  $Ca^{2+}$ ,  $Sr^{2+}$ , and mixtures or combinations thereof.

[0110] 4. The composition of claim 1, wherein the divalent cation is selected from the group consisting of  $Mg^{2+}$ ,  $Ca^{2+}$ , and mixtures or combinations thereof.

[0111] 5. The composition of claim 1, wherein the divalent cation is  $Mg^{2+}$ .

[0112] 6. A brine solution comprising a divalent to monovalent cation mole ratio of at least 0.05 and having a salinity greater than or equal to about 3%, where the brine solution is capable of supporting and sustaining microbial growth.

[0113] 7. The composition of claim 6, wherein the divalent cation is selected from the group consisting of  $Mg^{2+}$ ,  $Ca^{2+}$ ,  $Sr^{2+}$ ,  $Ba^{2+}$ , and mixtures or combinations thereof.

[0114] 8. The composition of claim 6, wherein the divalent cation is selected from the group consisting of  $Mg^{2+}$ ,  $Ca^{2+}$ ,  $Sr^{2+}$ , and mixtures or combinations thereof.

[0115] 9. The composition of claim 6, wherein the divalent cation is selected from the group consisting of  $Mg^{2+}$ ,  $Ca^{2+}$ , and mixtures or combinations thereof.

- [0116] 10. The composition of claim 6, wherein the divalent cation is  $Mg^{2+}$ .
- [0117] 11. The composition of claim 6, wherein the brine solution has a salinity between about 3% and about 15%.
- [0118] 12. The composition of claim 6, wherein the brine solution has a salinity between about 3% and about 13%.
- [0119] 13. The composition of claim 6, wherein the brine solution has a salinity between about 3% and about 10%.
- [0120] 14. A method comprising the steps of:  
feeding a contaminated brine solution to a biological reactor containing a mixed bacterial culture capable of degrading at least one contaminant under anoxic/anaerobic conditions;  
adding an effective amount of a divalent cation precursor to the reactor, where the effective amount of the divalent precursor is sufficient to maintain a divalent to monovalent cation mole ratio at a numeric value greater than or equal to about 0.05,  
degrading the contaminant in the contaminated brine solution for a time and at a temperature sufficient to reduce a concentration of the contaminant at or below a desired concentration while maintaining a suitable nutrient environment in the reactor and while maintaining the ratio greater than or equal to about 0.05.
- [0121] 15. The method of claim 14, wherein the reactor is sealed to reduce or eliminate oxygen from the reactor.
- [0122] 16. The method of claim 14, further comprising the step of:  
sparging or purging the reactor with an oxygen-free gas after feeding the brine solution and optionally during the degrading step.
- [0123] 17. The method of claim 14, wherein the gas is selected from the group of nitrogen, argon, and mixtures and combinations thereof.

[0124] 18. The method of claim 14, wherein the divalent cation precursor is selected from the group consisting of a soluble  $\text{Mg}^{2+}$  salt, a soluble  $\text{Ca}^{2+}$  salt, a soluble  $\text{Sr}^{2+}$ , a soluble  $\text{Ba}^{2+}$  salt, and mixtures or combinations thereof.

[0125] 19. The method of claim 14, wherein the divalent cation precursor is selected from the group consisting of a soluble  $\text{Mg}^{2+}$  salt, a soluble  $\text{Ca}^{2+}$  salt, a soluble  $\text{Sr}^{2+}$ , and mixtures or combinations thereof.

[0126] 20. The method of claim 14, wherein the divalent cation precursor is selected from the group consisting of a soluble  $\text{Mg}^{2+}$  salt, a soluble  $\text{Ca}^{2+}$  salt, and mixtures or combinations thereof.

[0127] 21. The method of claim 14, wherein the divalent cation precursor is a soluble  $\text{Mg}^{2+}$  salt.

[0128] 22. The method of claim 14, wherein the contaminant is selected from the group consisting of perchlorate, nitrate and mixture or combinations thereof.

[0129] 23. The method of claim 22, wherein the nutrient environment comprises adding an inorganic energy source or an organic energy source in amounts greater than a stoichiometric amount of electrons required to reduce the perchlorate and/or nitrate present in the brine solution for sustained microbial growth during the degrading step.

[0130] 24. The method of claim 23, wherein the inorganic energy source is selected from the group consisting of  $\text{H}_2$  gas, a hydrogen delivery chemical, and mixtures or combinations thereof.

[0131] 25. The method of claim 23, wherein the organic energy source is selected from the group consisting of acetate, ethanol, methanol, lactate, and mixtures or combinations thereof.

[0132] 26. The method of claim 14, wherein the contaminated brine solution is a perchlorate and/or nitrate contaminated ion-exchange regenerate brine.

[0133] 27. A method comprising the steps of:

passing a waste water stream including at least one ion-exchangeable pollutant through an ion-exchange resin able of exchanging the pollutant ion for a non-pollutant ion for a predetermined time or until the resin is no longer to exchange the pollutant ion with the non-pollutant ion;

stopping the waste water stream from passing through the resin;

passing a brine solution through the resin for a time sufficient to exchange all or substantially all of the pollutant ion with the non-pollutant ion to form a pollutant contaminated brine solution;

adding an effective amount of a divalent cation to the pollutant contaminated brine solution to adjust a divalent to monovalent cation mole ratio to a numeric value greater than or equal to 0.05 to form a stabilized, pollutant contaminated brine solution;

contacting the stabilized, pollutant contaminated brine solution with an effective amount of a pollutant degrading culture under anaerobic/anoxic conditions for a time and at a temperature sufficient to degrade a concentration of the pollutant to or below a desired concentration to form a crude treated brine solution; and

filtering the crude treated brine solution to remove the culture and to form a treated brine solution.

[0134] 28. The method of claim 27, further comprising the step of:

repeating the step of claim 26, where the brine solution comprises the treated brine solution.

[0135] 29. A method comprising the steps of:

feeding a waste water stream including at least one ion-exchangeable pollutant with a first column including a first ion-exchange resin able of exchanging the pollutant ion for a non-pollutant ion for a predetermined time or until the resin is no longer to exchange the pollutant ion with the non-pollutant ion;

switching the waste water stream feeding from the first column to a second column including a second ion-exchange resin capable of exchanging the pollutant ion for a non-pollutant ion for a predetermined time or until the resin is no longer to exchange the pollutant ion with the non-pollutant ion;

passing a brine solution through the first column for a time sufficient to exchange all or substantially all of the pollutant ion with the non-pollutant ion to form a pollutant contaminated

brine solution and to regenerate the first resin;

adding an effective amount of a divalent cation to the pollutant contaminated brine solution to adjust a divalent to monovalent cation mole ratio to a numeric value greater than or equal to 0.05 to form a stabilized, pollutant contaminated brine solution;

contacting the stabilized, pollutant contaminated brine solution with an effective amount of a pollutant degrading culture under anaerobic/anoxic conditions for a time and at a temperature sufficient to degrade a concentration of the pollutant to or below a desired concentration to form a crude treated brine solution;

filtering the crude treated brine solution to remove the culture and to form a treated brine solution;

switching the waste water stream feeding from the second column to first column; and repeating the above-identified steps.

[0136] 30. The method of claim 27, wherein the first and second ion-exchange resins are the same.